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The effects of the plyometric program on the physical quality of the Repeated Sprint Ability (RSA) in senior handball players)

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Abstract:

This study aims to show the impact of a physical preparation based on plyometrics on the development of the Repeated Sprint Ability (RSA) in senior handball players. For this purpose, we used the experimental method on an intentional sample of (12) male handball players subdivided into two homogeneous (control and experimental) groups from Nadjm Djemila -Setif- for 8 weeks of training with 2 sessions per week, and for data collection, we used the physical tests (15 m sprint and RSA test) .

After collecting the results and having treated them statistically, we conclude that the plyometric exercises had a big effect on the maximum speed and RSA for handball players, the study recommends the use of plyometric training in the process of physical preparation.

KEY WORDS: plyometric training; repeated sprint ability (rsa); handball

الملخص:

هدفت الدراسة إلى معرفة تأثير التدريب البليومتري في القدرة على تكرار السرعة RSA لدى أكابر كرة اليد. استخدمنا المنهج التجريبي وتم تطبيق البرنامج التدريبي على عينة عمدية متكونة من 12 لاعب مقسمة الى مجموعتين متكافئتين من فريق نجم جميلة – سطيف – لمدة 8 أسابيع. بمعدل حصتين في الأسبوع. استخدمت الاختبارات البدنية لجمع البيانات (15 m sprint and RSA test)، وبعد معالجتها احصائيا، توصل الباحث الى أن التدريب البليومتري له أثر كبير على القدرة على تكرار السرعة RSA والسرعة القصوى لدى لاعبين كرة اليد، توصي الدراسة باستخدام التدريب البليومتري في عملية التحضير البدني.

الكلمات المفتاحية: التدريب البليومتري؛ القدرة على تكرار السرعة؛ كرة اليد

1-Introduction:

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In the science and practice of sport and exercises, particular attention has been paid to the development of training strategies intended to improve performance- related physical qualities. (**Tabata, et al., 1996**)

Handball is a strenuous Olympic sport that consumes a lot of effort and therefore requires physical preparation, great physiological capabilities and integrates technical, tactical, and physical skills, this is especially true in high intensity situations. (**Moncef, et al, 2012, Foukia, et al, 2018**), which is a sport that requires physical efforts of high-intensity muscle power and of short duration, with emphasis on sprinting, jumping, throwing acceleration, deceleration, and rapid changes in direction. (**Moisés et al., 2017 ; Hermassi et al., 2018 ; Jorge Viaño et al., 2017**).

Bojsen et al (2015) indicates that handball involves activities of well-developed aerobic and anaerobic qualities. During the 60 minutes of match-play, the players work intensely for short intermittent times, for Marquez and Badillo (2006), Buchheit et al (2009) and Rhibi (2019) performance hinges upon to a large extent, on the aerobic and endurance capacities of the athlete, whose values of VO_2max and MAS are a fundamental determinant in order to maintain performance over an entire season, the longest phases at the handball for example are walking, slow running and fast stroke (about 81% of total time). (**Villanueva, et al, 2010**)

The anaerobic fitness unlike aerobic fitness, related to muscle mass and the ability to perform repeated muscle actions. (Rochcongar et al., 2013), the participation of anaerobic metabolism is important in handball, the anaerobic sector is called during shots, jumps, one on one, start for the counter-attack, defense work between 9m and 6m and. In addition, the phases of play are characterized by exercise-rest intermittent mostly less than 10 seconds. It is therefore evident that a handball team must be composed of players with good anaerobic aptitude (**Maurelli, 2018**).

Hermassi et al. (2014) and Cavar et al. (2018) sited that in handball, players are required to repeat sequences of short explosive efforts, such as sprints (<15 m) with changes in direction, jumping ability, throwing and sprinting, demonstrate the importance of anaerobic fitness which appears on explosive strength and anaerobic power to optimize the performance of elite handball players (**Mendez et al., 2010**).

In modern handball, one of the "athletic" difficulties is repeating sprints despite an often very short recovery time. This refers to the

notion of Repeated Sprint Ability (RSA). This notion has been the subject of much research, unfortunately little known to most coaches. (**Dumortier & Ziane, 2014**). It was shown that the intermittent nature of the activity was essential and particular, and that the player had to develop the ability to repeat sprints to be successful. (**Hervé, 2012**)

According to Bishop et al. (2003), speed resistance also called Repeated Sprint Ability (RSA) is "the ability to sprint, recover, and sprint again, without observing a drop in performance between the first and the last sprint. Now, the authors have a more qualitative approach to physical preparation for handball. Indeed, even if the sprint phases represent only 7% of the total time, it is during these moments that a team can gain the advantage over another (**Kyrolaine et al., 2004**).

RSA is a key factor in physical performance in team sports because it influences the end result of a match. (Rampinini, et al, 2007), RSA is considered an ability to repeat short sprints "10s, alternated with short recovery times less than 60 seconds, which should be distinguished from short intermittent exercises which would alternate the same type of effort with longer recoveries of 30 seconds. at 300 seconds. (**Girard , et al, 2011**)

Here has been little research about the best training methods to improve RSA. In the absence of strong scientific evidence, two principal training theories have emerged. One is based on the concept of training specificity and maintains that the best way to train RSA is to perform repeated sprints. The second proposes that training interventions that target the main factors limiting RSA may be a more effective approach. (**Delecluse, et al, 1995**) (**Newman, et al, 2004**)

Many authors highlight that the ability to repeat sprints is directly dependent on the maximum sprint speed on a repetition. From this observation, we can affirm that the muscular part in the work of repeated sprints is similar to that for a single sprint.

Indeed, they affirm that a training in plyometrics makes it possible to make the link between the increase in muscle stiffness (+ 7.8%) and the improvement in stride efficiency in running (+ 4, 1 to + 6.7%). however, it should be noted that plyometric training can play a very important role in the quality of sprint repetitions.

From a physiological point of view, plyometric contraction corresponds to an eccentric contraction of the muscle followed immediately by a concentric contraction. We can meet this kind of

solicitations in particular during jumps with counter-movement. This type of contraction involves the stretch-relax cycle of the muscle. Bosco tells us that this cycle is mainly due to the elasticity of muscles and tendons but also to the intervention of the myotatic reflex. The myotatic reflex is a reflex of shortening of a muscle linked to a too brutal stretching of this one. It is considered to be a protective mechanism of the muscle in order to avoid injury. (**Schmitz, 2013**), this method of training aims to improve the level of successive improvements in sports performance that depend on this characteristic in one of its stages (**Bouicha & Nacer, 2018**). Also, many researchers believe that the development of plyometric training is the most widely used method in explosive power and speed-characterized strength for many sports activities, which require merging maximum speed with maximum muscle strength (**Benzidane, et al, 2018**)

On the basis of the elements of the literature review presented above, the aim of this study was to measure the impact of a physical preparation based on plyometrics on the physical quality of the ability to repeat sprints in handball.

After stressing that training in plyometrics causes an improvement in maximum running speed by increasing muscle stiffness mainly and that maximum running speed is strongly correlated with performance in sprints repeated (**Schmitz, 2013**), we hypothesized that training in plyometrics will improve performance in repeated sprints in handball.

We therefore checked whether an 8-week plyometric cycle increases performance on a single sprint, and on the quality of sprint repetitions among handball players.

Objective of the study

The study aimed to know the effect of a training program based on plyometric exercises on repetition of speed and maximum speed, in order to determine the best way to develop the handball player's physical abilities and achieve the best possible result by developing the maximum speed and the ability to repeat the speed which is a key element in the characteristics of handball.

3- Procedural definition of the concepts mentioned in the research:

PLYOMETRIC TRAINING:

From a physiological point of view, plyometric contraction corresponds to an eccentric contraction of the muscle followed immediately by a concentric contraction. We can meet this kind of solicitations in particular during jumps with counter-movement. This type of contraction involves the stretch-relax cycle of the muscle. This cycle is mainly due to the elasticity of muscles and tendons but also to the intervention of the myotatic reflex. The myotatic reflex is a reflex of shortening of a muscle linked to a too brutal stretching of this one. It is considered to be a protective mechanism of the muscle in order to avoid injury (**Schmitz, 2013**).

The researcher concludes that plyometric training is directly related to the development of strength and strength, which is an advantage in speed, which makes it an important element in the development of the athlete's maximum speed.

REPEATED SPRINT ABILITY (RSA):

Repeated Sprint Ability (RSA) is "the ability to sprint, recover, and sprint again, without observing a drop in performance between the first and the last sprint (**Kyrolaine et al., 2004**).

RSA is a key factor in physical performance in team sports because it influences the end result of a match. (**Rampinini, et al, 2007**), RSA is considered an ability to repeat short sprints "10s, alternated with short recovery times less than 60 seconds (**Girard, et al, 2011**).

From the above, we can say that the development of repeated sprint ability (RSA) is a decisive factor for handball players because it is a sport characterized by frequent of sprints.

4- The methodological procedures used in the study:

4-1 Method and tools:

Zerouga and Nedjaimi (2020) say that method it is the road leading to the desired goal or the invisible thread that pulls the research from its beginning to the end in order to reach certain results.

For the concretization of our research, we saw it was necessary to use the experimental method in order to answer our initial questions, Delignieres and Duret define experimentation as "The empirical testing in a methodical way of a theoretical hypothesis" (**Ghoual and Oualid, 2020**).

- **Participants**

The study sample consists of twelve (12) male handball players from the Najm Riyadi Djemila (NRBD), they participated in the study for 8 weeks of training with two sessions per week who was selected deliberately, the sample was subdivided into two groups, with the same specifications (age, weight, height, the result of Max speed, and RSA), participant's characteristics are presented in Table 1.

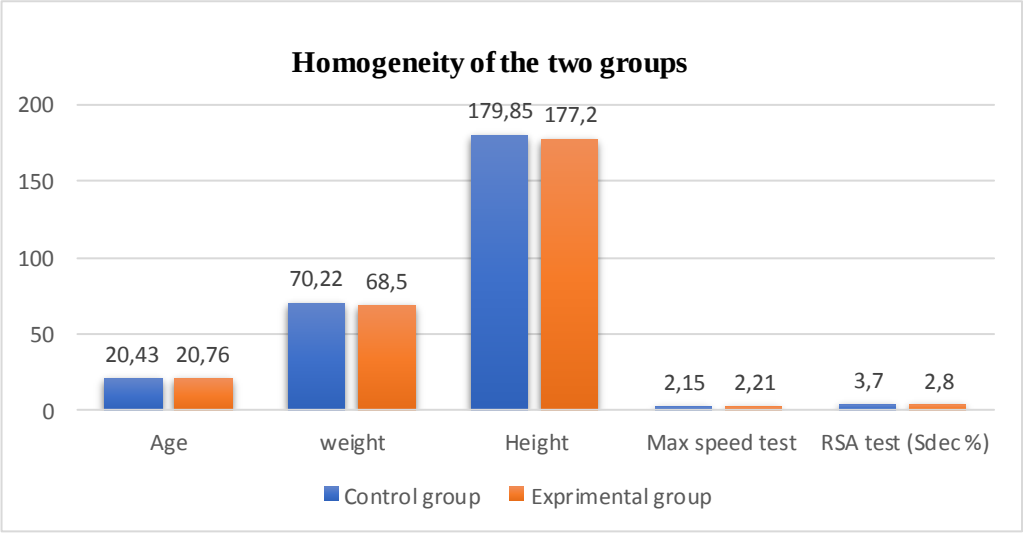
Table 1. Participant characteristics (mean (M)±standard deviation (SD)) / n=12

Groups	Par	Age	Weight (kg)	Height (cm)	Max speed	RSA Sdec (%)
Control group	6	20,43 ±0,5	70,22 ± 7.34	179,85 ±9,34	2,15 ± 0,27	3,7 ± 0,24
Exp group	6	20,76 ±0,5	68,5± 6.3	177,2± 5.8	2,21± 0,41	2,8 ± 0,26

Par: participants, S dec %: percentage decrease in speed, Exp: experimental

Source: Designed by the researcher

Figure1. Homogeneity of the two groups samples



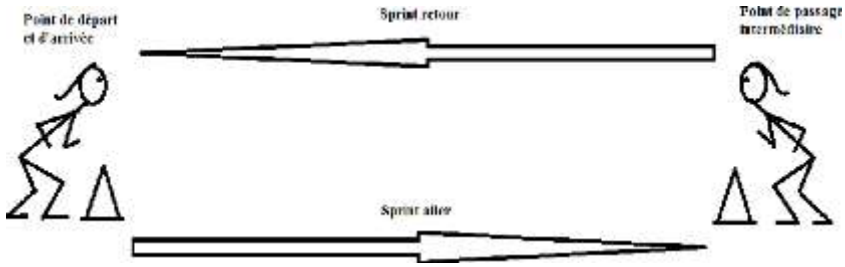
Source: Designed by the researcher

- ***Materials***

Assessment of the qualities of maximum speed and sprint repetitions:

We set up a 15-meter sprint test to measure the maximum speed over this distance and link it to the results of other tests.
Finally, a standardized test measuring RSA over 6 X (2 X 15m) in a sprint, with a recovery of 14 seconds between each round trip was proposed to assess the ability to repeat short sprints with a recovery time. weak, somewhat simulating handball activity (Figure 2).
The protocol for this test is to run as fast as possible over a distance of 30 meters in total (2 X 15 meters), losing as little time as possible when changing direction, and keeping the speed as high as possible. throughout the race. Six repetitions of this race must be performed to complete the test with a passive recovery of 14 seconds between each race. The raw data collected is the split times in each 30-meter sprint and the total time to complete all the runs. In addition, the best running time is a benchmark for calculating the ability to repeat sprints given as a decay score. Sdec (%) = (- 1) 100 according to Girard et al. (2011). (SCHMITZ, 2013)

Figure2. RSA measurement test (6 × (2 × 15 meters) back and forth)



Source: (Schwesig, et al., 2012)

- ***Design and Procedure***

This study is conducted during the preparation phase, we came up with physical training program, taking into account some basic principles that allow us to reach the achievement of previously established goals through the application of these training program while preserving the health and safety of athletes and not to expose them to injuries.

This program was built on the basis of 6 weeks plus two weeks for physical tests (pre-tests and post-tests) at a rate of 2 sessions per week (Saturday and Tuesday), and the sessions were performed at 18:30 in the Djemila multi-sports hall, in the wilaya of Setif. The implementation of this program was performed on the same days and at the time where the team used to train.

The study begins with series of one-week pre-tests that will be used to assess the athlete's maximum speed and repeated sprint ability RSA will serve as benchmarks for comparison with post-tests, for the control group will train in the regular daily program by focusing on the technical side, and the experimental group to which train

The experimental group will be applied to the plyometric training program. After the six-week training period comes the one-week post-test period, which will be done according to the same protocol and conditions as the pre-tests.

The planning of our intervention reveals three short mesocycles of two weeks each as well as two phases of tests before and after training. The first mesocycle is devoted to the work of horizontal plyometric with the objective of developing coordination, strength but also neuromuscular stiffness. The second mesocycle is oriented towards vertical plyometric work with jumps aimed more at height than length, which significantly increases the intensity. The volume

is also increased on this mesocycle in order to ensure a certain continuity in our protocol. Finally, the last two-week mesocycle is devoted to the work of vertical plyometric in bottom. We know that this type of stress is generally the most intense and it was therefore necessary to go through the previous stages before starting this mesocycle. The aim of this mesocycle was to mainly develop neuromuscular stiffness by the use of a much more intense movement braking phase and therefore a more intense return (use of elastic energy by the intervention of the mode of action of the stretch-relax cycle).

- **Statistical *Analysis***

All statistical analyses were performed using SPSS version 21.0 for windows. The results are expressed as the mean ± standard deviation. Correlation coefficients were calculated between the two tests using a Pearson test, a Student's t-test for paired samples was used, this statistical tool aims to define significant differences between the two compared tests. the level of significance was established at $p < 0.05$.

4-2 Presentation and Analysis of Results:

4-2-1. Presentation and analysis of Maximum speed inferred from the pre-test and post-test of 15m speed test for the two groups

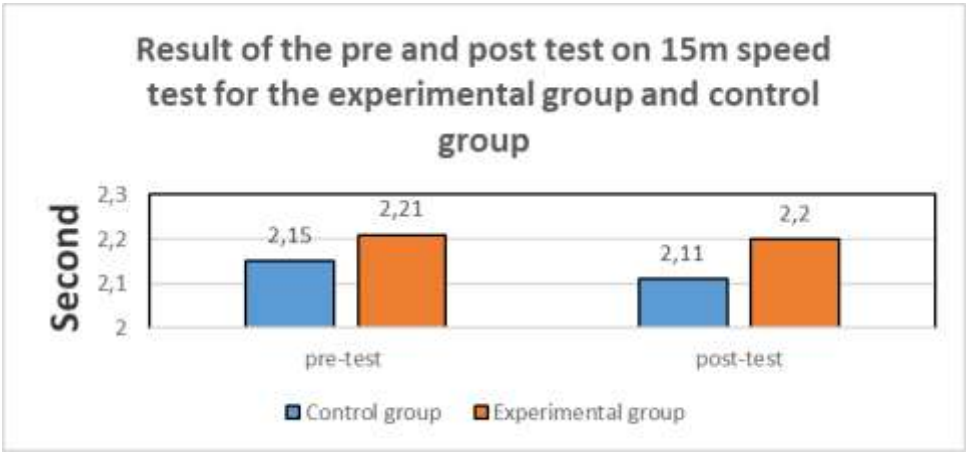
Table 2. show the results of the pre and post-test on Maximum speed for the two samples in the 15m test.

Max speed	Pre test		Post test		T Tab	T Calc
	SMA	S D	SMA	S D		
Control group	2,15	0,24	2,11	0,32	2,571	3.542
Exp group	2,21	0,26	2,09	0,27	2,571	3,471

SD: Standard deviation, SMA: arithmetic mean, TAB: tabular, calc: calculated, Exp: experimental

Source: Designed by the researcher

Figure 3. Shows the difference between the Arithmetic average of the results of the pre and post-test of the two experimental groups on 15m speed test.



Source: Designed by the researcher

Through Table (2), we found that the control group achieved an arithmetic average in the post-test, an arithmetic average of (2,11), and a standard deviation of (0,32), while the second experimental group achieved an arithmetic mean (2,09) and a standard deviation (0,27) in the post-test.

After statistical treatment of these data, we say there is a statistical significance in the effect training program with plyometric exercises on maximum speed at the level of significance (0.05) and the degree of freedom (10), and the slight increase for the control group was due to the daily routine training program.

4-2-2. Presentation and analysis of RSA inferred from the pre-test and post-test of RSA for the two groups:

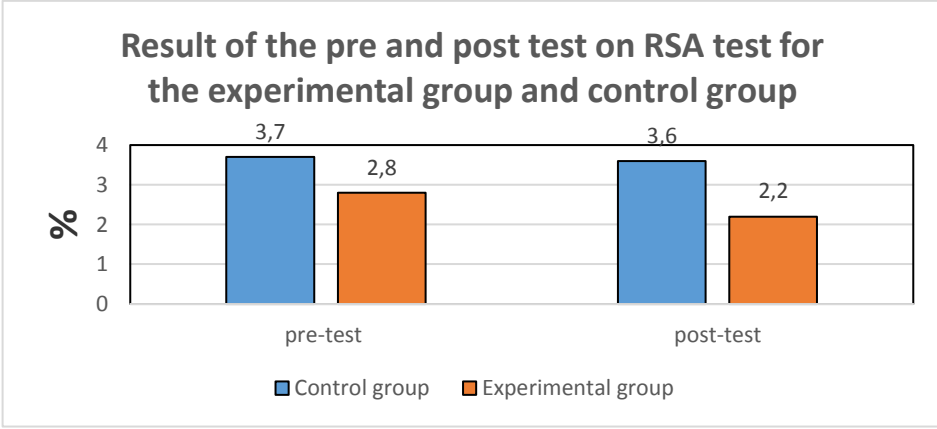
Table 3. show the results of the pre and post-test on a percentage of speed decrease for the two experimental samples in the RSA test.

RSA	Pre test		Post test		T Tab	T Calc
	SMA	SD	SMA	SD		
Control group	3,7	0,27	3,6	0,34	2,571	3.069
Exp group	2,8	0,41	2,2	0,21	2,571	3,132

SD: Standard deviation, SMA: arithmetic mean, TAB: tabular, calc: calculated, Exp: experimental

Source: Designed by the researcher

Figure 4. Shows the difference between the Arithmetic average of the results of the pre and post-test of the two experimental groups on RSA test.

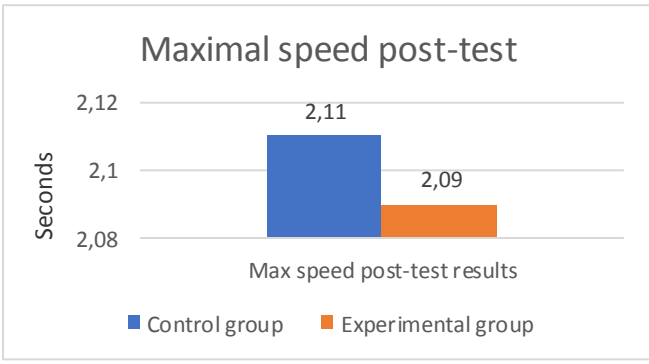


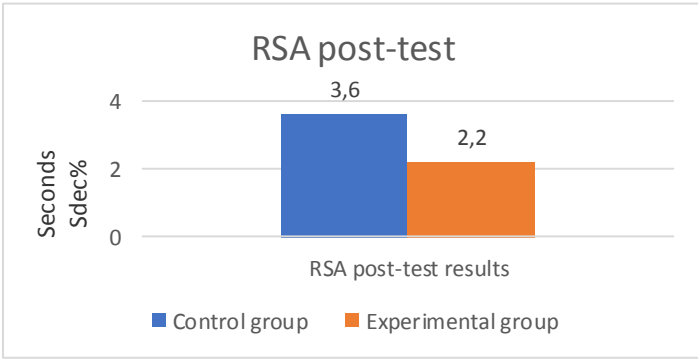
Source: Designed by the researcher

Through Table (3), we found that the control group achieved an arithmetic average in the post-test, an arithmetic average of (3,6), and a standard deviation of (0,34), while the second experimental group achieved an arithmetic mean (2,2) and a standard deviation (0,21) in the post-test.

After statistical treatment of these data, we say there is a statistical significance in the effect training program with plyometric exercises on RSA at the level of significance (0.05) and the degree of freedom (10), and the slight increase for the control group was due to the daily routine training program.

Figure 5. shows the results of the post-test on maximal speed and RSA for the two groups.





Source: Designed by the researcher

4-3 Discussion and interpretation of the results:

From the analysis and interpretation of the results obtained after the completion of the proposed program, the results show that the impact of physical training with plyometrics exercises on the development of the ability to repeat sprints RSA for handball players bigger than the classic training program.

We found that there is a significant difference between the two-arithmetic average of the experimental and control groups in the post-test on RSA and maximal speed, players who followed physical training program with plyometrics exercises influenced the RSA and maximum speed by way greater than control group (2,21passed to 2,09 on maximum speed and 2,8 to 2,2 on RSA test) for the experimental group, while the control group achieve (2,15 passed to 2,11 on maximum speed and 3,7 to 3,6 on RSA test).

Our results confirm those Hermassi who sought the RSA test score has a moderate to large association with other explosive power in elite adolescent handball players. RSA may provide a useful composite index on responses to training or rehabilitation, and is very suitable for monitoring athletic performance of the lower-limbs of elite adolescent handball players. In accordance with our hypothesis, the main finding from this study is that the performance indices of the RSSA test were significantly associated with several explosive athletic qualities related to handball. (**Hermassi, et al., 2014**)

Through the experimental work of Schwesig, R et al that a very large correlation was reported between lower body anaerobic power, and performance time in the RSA test. The leg muscle strength is important for both acceleration and velocity over short distances. These two characteristics must be well developed in adolescent handball players to allow the quick changes of direction over shorter sprint distances required in successful players. Sprinting, acceleration, and rapid changes in direction are inherent to both practice and competition in handball. (**Schwesig, et al., 2012**)

This is what was indicated by Moisés et al that study the effects of 3 pre-conditioning interventions (squat exercise (SQ), plyometrics (PL), and sprints with additional load (SL) on sprint ability (RSA) performance in professional handball players, they found that the plyometrics exercises contribute to the athlete developing maximum speed over short distances and thus improving the result during the RSA test. (**Moisés, et al., 2017**)

Ibo-bainguié examined the effect of training program of strength on athletics qualities for football players, the main results presented establish a significant difference between the pre and post-test. Indeed, this study shows that a plyometric program for footballers significantly improves: the speed of sprints over 30 m and the RSA. (**Ibo-bainguié, 2016: 17**)

Hermassi and Turner et al also found that plyometric exercises increase the strength of the lower limbs, also develop the isolated speed and the speed of one run, and thus develop the RSA. (**Hermassi, et al, 2011**) (**Turner, et al, 2015**)

Schmitz study the impact of a physical training based on plyometrics on the development of the ability to repeat sprints in the feminine handball. For this, we compared two groups of players using plyometric methods. The results show that the performance improved for both groups vertical jump and sprint repetitions and conclude that plyometrics efficacy improves performance by repeated sprints. (**Schmitz, 2013**)

Conclusion:

The aim of this study was to show whether training in plyometrics improved performance in RSA for handball players. In other words, does a physical preparation program based on plyometrics improve the physical qualities necessary for performance in repeated sprints? According to the results obtained and the correlation analyzes carried out between the different factors, it would seem that the improvement in muscle stiffness is largely responsible for the improvement in RSA.

We sought to improve neuromuscular stiffness through the plyometric method in order to improve maximum running speed. (**Hermassi, et al, 2011**)

By this development of maximum speed, we also expected to obtain an improvement in the ability to repeat sprints because we know that these two parameters are closely related. (**Schwesig, et al., 2012**) , the present results provide further evidence that the relative explosive leg power is an important aspect of RSA ability.

We can recommend using the results of this study by focusing on plyometric exercises in the physical preparation process at the beginning of the season in order to develop the anaerobic capabilities (RSA, maximum speed, strength of lower limbs) which allows the trainer to shorten time and effort in the physical preparation process.

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